and Mineral Names approved 205 new mineral names, so that about forty new species are being added annually.

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THE AMERICAN MINERALOGIST, VOL. 54, MAY–JUNE, 1969

THE SIGNIFICANCE OF TWINNING IN Ag_2S

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ABSTRACT

Twinning in Ag_2S is observed to form, on heating, well below the 177°C inversion from low-temperature Ag_2S, acanthite, to the high-temperature form, argentite. This twinning, premonitory of the inversion, is preserved upon subsequent cooling to room temperature. Therefore, the presence of twinning in Ag_2S cannot be used as a minimum-temperature indicator: the high-temperature crystal structure may never have existed.

INTRODUCTION

Evidence for the *bcc*[1]$\rightleftarrows$monoclinic phase transition of Ag_2S has been used extensively as a minimum temperature indicator of mineral formation in ore deposits. Ramdohr (1960) stated that the twinning frequently observed in natural Ag_2S results from this inversion, and that the presence of twinning indicates initial deposition above approximately 177°C; he considered Ag_2S which is untwinned as having formed below this temperature. However, as discussed below, this twinning need not be associated with the inversion.

Two polymorphs of Ag_2S composition have been described as distinct mineral species. Argentite commonly occurs with cubic morphology and displays characteristic twinning in polished sections. Acanthite has monoclinic structure and morphology and is usually untwinned in polished sections. The compound Ag_2S inverts reversibly from a low-temperature monoclinic form to a higher-temperature cubic (*bcc*) form (Kracek, 1946). This transition is composition sensitive: $177.8° \pm 0.7°C$ in the presence of sulfur, $176.3° \pm 0.5°C$ in the presence of silver (Kracek, 1946). Ag_2S with the cubic structure is nonquenchable–*i.e.*, it will not persist metastably below the transition temperature–in this respect it is similar to β quartz.

[1] Body-centered cubic.

The cubic morphology of the nonquenchable phase (argentite) is often preserved in ores, but all room-temperature Ag_2S X-ray diffraction patterns reveal the monoclinic symmetry of acanthite (Ramsdell, 1943). Therefore, usage of argentite as a mineral name refers to a pseudomorph of acanthite after argentite.

Discussion

Sadanaga and Sueno (1967) reported formation of twinning in Ag_2S at temperatures below that of the inversion. They heated natural Ag_2S by means of a small furnace attached to the goniometer head mounted on a Weissenberg camera. The twinning of natural argentite observed at low temperatures (twin plane[1] $(\bar{1}03)$, obliquity 1°17′) upon heating remained unaffected to approximately 152°C. At and above this temperature,

Table 1. Synthesis of Ag_2S and Observations on the Formation of Twinning

Reactants	Temp., °C	Time, days	Product at 25°C[a]
2Ag+S	185±2	36	Twinned
2Ag+S	168±3	37	Twinned
2Ag+S	156±2	12	Twinned
Natural Ag_2S[b]	152±7	~1	Twinned
2Ag+S	140±3	31	Not twinned

[a] As observed in polished section.

[b] This experiment is taken from Sadanaga and Sueno (1967). The twinning was observed in Weissenberg photos.

twinning due to several other laws was observed. The intensities of reflections due to the second individual of the twin increased as the temperature of the inversion was approached. Thus, Ag_2S shows a progression of twin formation with increasing temperature premonitory of the 177°C inversion.

During a study of the Ag-Fe-S system (Taylor, 1968), Ag_2S was synthesized by heating of Ag and S together in a 2:1 atomic ratio in sealed, evacuated, silica-glass tubes. The pertinent experiments are listed in Table 1. The temperature of the experiments at 156°C was closely monitored; the heat of reaction was not observed to measurably raise (*i.e.*, ~1°C) the temperature of the charge. Examination of polished sections of the charges, after rapid cooling to 25°C, revealed numerous inversion-like twins; the appearances of two samples of Ag_2S synthesized at 168° and 185°C were very similar. Thus, the twins formed below the inversion temperature are preserved upon cooling to room temperature. The Ag_2S

[1] Acanthite space group $=P2_1/n$; cell dimensions at 25°C: $a=4.231$ Å, $b=6.930$ Å, $c=7.861$ Å, and $\beta=99°33'$ (Sadanaga and Sueno, 1967).

synthesized at 140°C and annealed for 1 month showed no twins. The possible effects of substitution solid solution, directed stress on twin formation, and the "erasure" of twinning by prolonged heating of argentite at low temperatures have not been investigated to date.

The present observations throw serious doubt on the interpretation of twinning in Ag_2S as evidence for initial formation of argentite (i.e., above 177°C) at least until such a time that inversion twinning can be readily distinguished from "premonitory" twinning. Twinning takes place as low as 152°C; therefore, the twinned low-temperature form may occur, with anhedral morphology, but need never have possessed the high-temperature crystal structure.

ACKNOWLEDGMENTS

I wish to gratefully acknowledge the suggestions and criticisms of Professors J. D. H. Donnay, P. Ramdohr, and L. S. Ramsdell and Drs. G. Donnay and G. Kullerud.

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THE AMERICAN MINERALOGIST, VOL. 54, MAY–JUNE, 1969

TWIN LAWS AND COMPOSITION OF PLAGIOCLASE FELDSPAR IN TUFFS

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ABSTRACT

Universal stage measurements of 105 plagioclase crystals from seven tuffs in the western United States show that twin laws with the (010) composition plane constitute 94.3 percent. The composition range of the plagioclase is from An_{10} to An_{37} with 54 percent in the An_{24-28} interval. Most of the plagioclase has high-optics: a few crystals display transitional optics.

INTRODUCTION

As part of a study on the use of plagioclase feldspar for provenance studies (Pittman, 1962), a literature survey was made of the characteris-